A Wideband Microwave Solid-State FM Deviator

Existing frequency modulated microwave sources are typically limited to either relatively narrow frequency deviations ($<\pm 20$ MHz) or relatively low baseband response (<10 MHz), unless complicated techniques are employed. The objective of the work described in this correspondence was to develop a simple solid-state microwave deviator with greatly extended deviation and baseband response. Specifically, a frequency deviation of ± 100 MHz centered at 1.3 GHz with a linearity of less than 2 MHz, a power output of 120 mW flat to 1 dB and a baseband response from dc to 60 MHz were established as goals.

The FM deviator designed for this purpose utilized a transistor oscillator which operates at its fundamental frequency. In order to obtain the required broadband deviation characteristics, a simple LC resonant circuit containing the baseband-voltage dependent collector-to-base capacitance of the transistor, a varactor and an external inductor was utilized, as shown in Fig. 1. In this way the ratio of energy stored in the variable capacitances to the total energy stored in the resonant circuit was maximized. Furthermore, since the higher voltage is applied to the transistor as the frequency increases, the output power is maintained relatively flat over the whole range of interest.

Linearization of the frequency-voltage characteristics was accomplished by shaping the input voltage characteristics. For this purpose Schottky barrier diodes were used, as shown in Fig. 1.

Using Fairchild MT1038 transistors operating at L-band, several FM deviators were constructed. The best of these had a linearity of less than 2 MHz for a peak-to-peak deviation of 200 MHz and a differential nonlinearity of less than ± 6 percent. The deviators are capable of providing an output power of greater than 100 mW over the band, flat to within 1 dB. Figure 2 shows the RF output response and the frequency versus baseband voltage characteristic. The baseband frequency characteristic is flat to within ± 1 dB from dc to 60 MHz as shown in Fig. 3. On a spectrum analyzer with 1 kHz IF bandwidth the noise level of the deviator was more than 60 dB below the carrier at 100 KHz away from the carrier. No spurious responses were observed over a several hundred megahertz range.

Similar results have also been obtained with push–pull oscillators where the varactor and RFC's are completely eliminated.

W. J. Clemetson
Bell Telephone Labs., Inc.
Murray Hill, N. J.

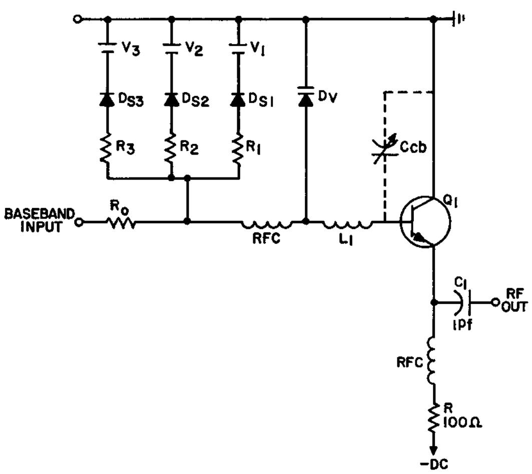

Fig. 1. Schematic diagram of linearized L-band FM deviator.

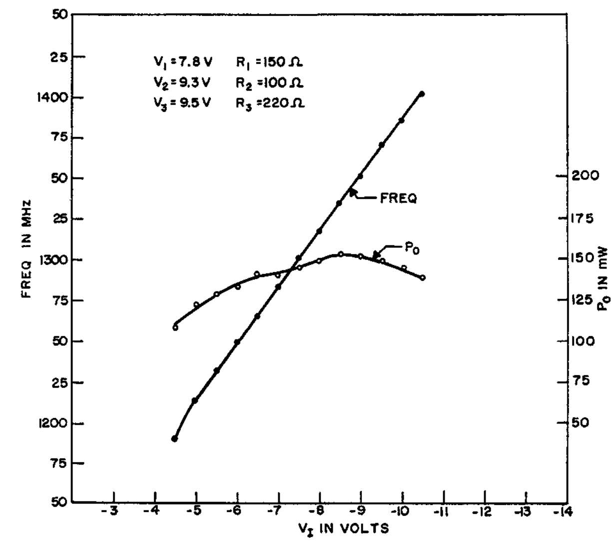

Fig. 2. RF characteristics of FM deviator.

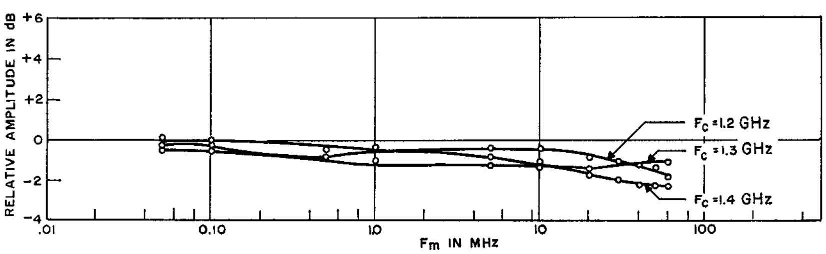

Fig. 3. Baseband response for three RF carrier frequencies.

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Comments on "Longitudinal Waves in a Hot-Nonuniform Plasma"

In a recent correspondence Lonngren[1] derived the general wave equation for an inhomogeneous isotropic warm electron plasma in the form:

$$-\nabla\times\nabla\times\bar{E}+\frac{a^2}{c^2}\nabla\nabla\cdot\bar{E}+k_0^2(1-X)\bar{E}=\frac{a^2}{c^2}\frac{\nabla N_0}{N_0}\nabla\cdot\bar{E} \qquad (1)$$

where $a=[\gamma K T_0/m]^{1/2}$ = acoustic velocity of the electron gas, $X(\bar{r})=e^2N_0(\bar{r})/\omega^2\epsilon m$, $k_0=\omega/c$, $k_1=\omega/a$ and $\gamma=C_p/C_v$.

The general wave equation for an inhomogeneous gyrotropic warm plasma with a static magnetic field was derived by Unz[2] in the form:

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[1] K. E. Lonngren, "On longitudinal waves in a hot-nonuniform plasma," *IEEE Trans. on Microwave Theory and Techniques (Correspondence)*, vol. MTT-14, pp. 494–495, October 1966.

[2] H. Unz, "Wave propagation in inhomogeneous gyrotropic warm plasmas," *Am. J. Phys.* (to be published).